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office.

Newtown
Donard
Co. Wicklow
15/11/05

I submit report for An Bord Pleanala ref: PL27211913 by David Ball, Hydrogoelogist, re planning Application 05/2444 (Wicklow County Council) which refers to site under consideration for Waste License 204-1,

regards,

Ailish Greene

PLANNING APPEAL
PROPOSED INTEGRATED WASTE MANAGEMENT FACILITY AT WHITESTOWN LOWER, COUNTY WICKLOW (PL 27.211913)

ASSESSMENT OF THE PROPOSED DEVELOPMENT IN RELATION TO SITE SUITABILITY AND HYDROGEOLOGY

REPORT FOR AN BORD PLEANALA

July 2005

By
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28 New Bride Street, Dublin 8

- INTRODUCTION

Proposals to develop a new, modern landfill or waste management facility are usually based upon a long, and often exhaustive, site selection process. The objective of site selection process is usually to find a location (often a green field site), that is convenient to the source of the waste, where the natural site characteristics possess advantages in relation to construction, and the prevention of pollution and contamination of land and water resources in the future. It is implicit in the search for a site that a landfill will remain a potential pollution hazard for a long period after the facility has been closed. So called 'dry tomb' landfills, where the waste is finally sandwiched between an impermeable lower liner and an upper impermeable cap, are still expected to be a source of leachate several hundred years after the facility has been closed. To put the time scale into a hypothetical historical context; if the Normans, after their arrival in Wexford, had constructed a modern dry tomb landfill, we would still expect to find that it was a low level source of elevated ammonia and metals. It is also implicit in the search for a modern landfill site that engineered barriers to prevent the leakage and dispersal of leachate will probably fail over this extended time period. Modern, engineered landfills are a recent phenomenon. The integrity of plastic liners, leachate collection systems and post closure covers have not been field tested over hundreds of years. Therefore it is sound practise for modern landfills to be proposed at sites where the natural materials below, and down gradient, of the site will form a secondary, natural, barrier or impediment to the migration of leachate, if, and when, the engineered barriers fail. It is also sound practise to place modern landfills at sites that are not directly above, or up gradient, of important groundwater and surface water resources and flow systems, whether or not these resources are fully utilised or in pristine condition. Modern landfills are wisely sited with a sense of responsibility for the future. One of the basic guiding principles in modern landfill site selection and design, is to try to avoid leaving an unmanaged legacy of polluting matter for future generations.

The proposed landfill development is unusual. The site has not been chosen at the end of a systematic investigation of alternatives. Instead the development is proposed as a commercial solution to an existing problem. An existing sand and gravel quarry has been used as an unauthorised dump for a variety of waste, over a period of time. The owners of the sand and gravel quarry have sold the site. The new owners have proposed a complex phased development that consists in summary of:

- Complete the extraction of the remaining commercial sand and gravel resources
- Excavate and process the unauthorised existing waste on the site
- Construct an engineered landfill in stages
- Deposit the processed waste from the site in the landfill
- Receive, process and deposit waste from nearby unauthorised landfills
- Receive, process and deposit new waste from Wicklow, Kildare and south Dublin

This proposal appears to have many advantages. It appears to provide a solution to the unauthorised waste problem in west Wicklow, and to provide new landfill capacity for Wicklow and adjacent counties.

Planning permission for the proposed development has been refused by the planning authority.

An application for a waste licence was lodged with the EPA in March 2004. The EPA has requested additional information, which was submitted by the developers in May 2005. There are therefore two concurrent processes with accompanying information in progress. Also, in the background, there are legal proceedings. These legal proceedings are only relevant to the assessment of the appeal, in so far as it is understood that there are data on the site and the waste in the site, that are reserved for the legal proceedings, and not available for consideration by the Board.

The information provided in the original planning application EIS and the 1st party grounds for appeal has been supplemented by the recent submission of a Preliminary Risk Assessment Report prepared in response to the request for additional information by the EPA. This risk assessment is a heavily revised and up dated version of a previous risk assessment report included in the planning application. There have also been third party observations on the first party appeal, and there has been a first party response to the third party observations. The overall result is that there a numerous documents for consideration in this appeal. These documents appear to contain a large amount of information, assessment and opinion. There are numerous appendices and attachments to the documents. There are numerous maps and plans, data tables, model simulations and graphs. The information on the site and matters relating to geology, soils, water, waste and the environment appear to be split into separate documents, which also contain numerous duplications. For example the sections in the main EIS on geology and hydrogeology are quite short, but much longer and more detailed descriptions are contained in the risk assessment report in an appendix. This report has since been revised for the EPA. The outcome is that there appears to be no single coherent section that fully describes the existing environment, and then the probable impacts of the proposed development on this environment.

I have made an inspection of the site and observed several relevant features that are not fully described in the available documentation.

I believe that the file and existing documentation provides an adequate basis for the assessment of the appeal.

The documentation provides a considerable description of the engineering designs, construction schedules, and monitoring and mitigation measures for the proposed development. The documentation also contains a considerable quantity of argument and counter argument between the 1st, 2nd and 3rd parties.

It would be easy for an assessment to become engrossed in the detail and argument, and for the issues to appear to become very complex. However, the assessment of the proposed development is relatively straightforward.

Permission for a major new landfill requires the proponents to have acquired a sound understanding of the site characteristics and the processes taking place on, in and under the site.

Therefore the first part of the following report is an assessment of the available information and the processes that influence the construction on the site and the long-term integrity of a development on the site and its potential influence outside the site.

2. Description and discussion of information on Soils, Geology, Hydrogeology and Hydrology

2.1 The EIS

The main EIS report describes Soils Geology and Groundwater in Section 3.7 and Surface Water in Section 3.10. I will briefly describe the main content and issues raised in these sections. I will also discus to some of the omissions and inconsistencies in the EIS.

Section 3.7.1 refers to investigations carried out by the developers Brownfield Restoration Ireland Ltd (BRI) or their consultants Environment & Resource Management Ltd (ERML), such as trial pitting, sample analysis, drilling of boreholes groundwater sampling and laboratory analysis and groundwater flow mapping. However it states that the findings from these investigations are included in the Preliminary Risk Assessment Report in Appendix. 9 of the EIS and are only summarised in the main body of the EIS.

Section 3.7.1 in the EIS provides a description of the soils geology and groundwater principally based on desk studies and reference to documents prepared by the Geological Survey of Ireland (GSI).

The relevant details are as follows:

The site has been used for sand and gravel extraction for some time.

The sands and gravel deposits are Quaternary age glacial sediments that rest upon a bedrock composed of

1. The Cambrian age Butter Mountain formation – dark blue grey slates with thin beds of grey quartzite. This formation underlies the site. These rocks are sediments that were, to varying degrees, deformed and metamorphosed by the intrusion of the Wicklow Granites.

2. A separate member of the Butter Mountain formation called the Donard Andesite Member. Andesite is a volcanic rock. The Donard Andesite Member is expected to underlie part of the flood plain to the west of the Carrigower river and underlie the sands and gravels in the eastern valley floor and valley sides.

The EIS contains no reference to the structural geology of the area. Though a map in figure 3.7.2 shows a major fault just to the north of the site, there is no description or discussion of the impact on permeability of the hard rock aquifers caused by brittle deformation of the bedrock. The major fault to the north of the site has been mapped as extending in full for 21 km from Lugnaquilla, in a west north west direction into the plains of Kildare. This major structural feature may include associated subsidiary faults that traverse the site.

The EIS states that the residue of the sand and gravel deposits are up to 12 metres thick on the site.

The EIS quotes the GSI that the flood plain on either side of the Carrigower river is composed of alluvium. However there is no information on the thickness of this alluvium, or discussion, for example, of whether the alluvium is simply a thin veneer of sediment overlying a thick sand and gravel valley fill.

The EIS section on Site Geology states that the GSI well data base has been searched for information on existing water wells within 2km of the site and 12 wells have been found from these existing records. It is not clear whether the applicant has carried out a separate field investigation to identify and determine the characteristics of local wells.

The EIS section 3.7.1.3 on Site Hydrogeology starts with Groundwater Classification and begins with an unusual statement :

> "Based on desktop reviews, it is understood that three hydrogeological units underlie the site, namely:
> - Shallow water table in overburden sand and gravels and upper fractured bedrock.
> - Deeper bedrock aquifer – Butter Mountain Formation.
> - Deeper bedrock aquifer – Donard Andesite Member
>
> The Geological Survey of Ireland has not classified the water-bearing sand and gravels at this site."

This statement is unusual because it gives no indication of the applicant's site specific findings or interpretations, and refers instead to a discrimination of three units based upon a desk top review of un-specified information. It is also unusual to lump together a shallow groundwater system in sands and gravels with the groundwater flow system in the upper fractured bedrock. The aquifer characteristics, such as porosity and permeability, of recent sand and gravel deposits are usually different from the aquifer characteristics of an ancient impermeable rock that has been fractured. There may be some reason for lumping these two groundwater units together, but it is not given. It would be usual to include the upper fractured bedrock as a transitional zone in the bedrock unit. There is also no account given for why the applicant thinks that just the upper bedrock is fractured. Usually if a rock is fractured, it is fractured throughout. Weathering of the fractures, at or near the surface, often opens up the structure of the rock mass and increases the permeability of the upper bedrock. Perhaps the description in the EIS is loose, and the intention was to refer to 'an upper weathered and fractured bedrock zone'.

There is also no description given of the aquifer characteristics of the main Butter Mountain Formation, or the Donard Andesite Member. Instead there is reference to the GSI's classification of both rock types as being a 'Locally Important Aquifer which is moderately productive in Local Zones' (Ll). The use of the GSI's aquifer classification is relevant only in so far as it relates to protection of groundwater resources. It is evident in general terms that the groundwater resources in an ancient slate or andesite rock are likely to be limited, but groundwater resources are not the prime issue in relation to this development.

The prime groundwater issue is the role that the groundwater system, specifically below the site, may have in either constraining the development of the site, or transporting leachate generated at the site, to the nearest river, roughly 80 -100 metres away. It is evident at first glance that the proposed development is not sitting on, or up gradient, of some major groundwater resource; that is, or could be, exploited as a major source of high quality water. Instead the proposed development is sitting in a partially excavated sand and gravel aquifer that provides part of the base flow for the Carrigower river.

The GSI's Groundwater Resource Protection classification has been used to describe the groundwater vulnerability. The applicant correctly states that where the sand and gravel has been excavated the Butter Mountain bedrock aquifer will have a vulnerability rating which is probably Extreme.

The applicant has taken the combination of the GSI aquifer classification (groundwater resource classification) and the vulnerability rating and has applied them to the GSI - EPA matrix for Groundwater Protection Responses for Landfills, but for just the bedrock aquifer alone. The applicant has discounted the sand and gravel aquifer. The applicant has accepted the extreme vulnerability rating and used the Ll aquifer classification for the bedrock which produces an $R2^2$ Resource Protection response.

The $R2^2$ Resource Protection response is advantageous to the applicant because the GSI and EPA guidelines agree that a landfill is acceptable subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence.

The use of the GSI – EPA response matrix is not logical for three reasons:

1. The applicant has already stated in section 3.7.1.3.1 that the
   "Shallow water table in overburden sand and gravels and upper fractured bedrock"
   form a single hydrogeological unit.

   Therefore if the upper bedrock has the same characteristics as a sand and gravel aquifer, the aquifer category should be Lg (meaning a Locally important sand/gravel aquifer) and not Ll. Extreme vulnerability of a Lg aquifer invokes a response that should be $R3^2$.

   The GSI – EPA guidelines state that a landfill is not generally acceptable when there is an $R3^2$ response.

2. The applicant has ignored the aquifer characteristics of the sand and gravel aquifer where this aquifer remains in the east of the site. The applicant proposes to site part of the landfill cells above a sand and gravel aquifer with a saturated thickness of over three metres. Extreme vulnerability of a permeable sand and gravel aquifer would also invoke a $R3^2$ response in the GSI – EPA matrix.

3. The use of a groundwater protection response matrix to justify the acceptability of the site is not sound because it is not only the groundwater resource which is at risk. Groundwater resources are not static. Groundwater flows 'downhill' to the nearest base level discharge area. The applicant's data shows, a groundwater gradient from the site towards the river. Groundwater therefore has the potential to move from the site to the river. Therefore site selection should be viewed in terms of protection of a groundwater flow

system rather than a groundwater resource. The groundwater flow system links the site to the river.

Section 3.7.1.3.4 states that there are no known groundwater users down gradient of the site.

Section 3.7.1.3.5 entitled Groundwater Flow, states that groundwater levels measured in February 2004 were used to construct a groundwater map that shows that flow is from the north west towards the south east with an average gradient in the range of 0.02 to 0.03.

This section draws attention to a table of groundwater measurements made in boreholes on the site. The table shows data collected in December 2003 and February 2004. This table shows that groundwater levels commonly rose by 0.5 to 1 metre between December and February. There are no monitoring data for the fluctuation of groundwater levels during the course of a year.

It is of note that there are no boreholes or groundwater level measurements in the flood plain near, or adjacent, to the Carrigower river. The site boundary extends to the river bank, therefore permission to construct trial pits or water level monitoring boreholes between the gravel pit and unauthorised waste deposits and the river would not be an issue. There does not appear to have been an attempt to obtain groundwater information between the quarry and the river and relate groundwater levels to river water levels. In other words there appears to have been no attempt to gather information in order to specifically understand the link between the present or proposed development and the river. All groundwater contours shown on accompanying EIS maps stop at the eastern boundary of the quarry away from the river. Whereas these contours are extended considerably beyond the northern, western and southern site boundaries. At first glance it appears from the map that the groundwater flow gradient stops before it reaches the river flood plain.

Section 3.7.1.3.6 entitled Groundwater Quality relates the results of groundwater sampling to the EU Drinking Water Regulations. The section states that the groundwater immediately downgradient of the waste zones on the site shows elevated concentrations which indicate the presence of leachate in the groundwater.

Section 3.7.2 entitled Potential Emissions contains an introductory paragraph that states that leachate is a potential threat to groundwater quality. Subsection 3.7.2.1 entitled Present Emissions states that the existing waste in unlined areas present a potential for ongoing emissions into the groundwater/surface water environment.

Section 3.7.2.2. entitled Future Emissions describes five potential emissions from the proposed development to groundwater. These are

- Leachate released during the removal of previously deposited wastes
- Leachate released from the fully engineered lined landfill facility
- Machinery and operational vehicle fluid losses in parking areas, refuelling areas and maintenance areas
- Vehicle and machinery fuel storage
- Hardstand area runoff

Section 3.7.3 is entitled 'Description of Likely Impacts'

The section starts with a reasonable statement that the likely impact of the present situation, where unauthorised waste has been deposited in the quarry, will lead to leachate migrating vertically into the sands, gravels and weathered bedrock and then travelling in a south easterly direction. This statement is reasonable because it identifies the weathered bedrock, and accurately describes the flow direction to the south east. However it is notable that the statement omits reference to the river as the logical receptor of this contaminated groundwater flow.

The second part of this EIS section is unusual because "the author has interpreted 'Likely Impacts' as those impacts likely to take place in the event that the necessary containment and preventative measures are not incorporated in the development design". It seems unreal to try to describe in detail the likely impacts of a development that has not been proposed. The applicants are proposing an engineered contained landfill.

It is also seems unreal after the above statement about not incorporating containment and preventative measures, to then state that an uncontrolled emission of leachate arising from a breach of the liner system will lead to a 'virtually undetectable reduction in groundwater quality down gradient of the site'.

A final statement perhaps clarifies, but does not explain the confusion. The final bullet point in section 3.7.3 refers to 'a theoretical computation that suggests a potential leakage of less than 100 m^3/year' from a breach in the liner system, and then continues with a statement that the estimated leakage of leachate from an unlined landfill (Preliminary Risk Assessment Report) could be as much as 12,000 m^3/year.

Section 3.7.4 is entitled Mitigation Measures. This section basically states that the proposed engineered landfill will mitigate the likely impacts of a unlined new landfill. As there is no proposal for an unlined new landfill before the Board, this description seems unnecessary. It would seem more relevant to describe the likely impacts of the proposed development and then describe the measures required to mitigate the impacts of the proposed development. However it does summarise the main design features of the proposed engineered landfill and the manner in which these engineered features will contain potential pollutants and yet permit the flow of groundwater under and around the landfill cells. In effect the proposal is to construct a landfill and associated facilities that is isolated from the natural soils, sands, gravels, bedrock and groundwater flow system. The proposed designs will be discussed and assessed in appropriate detail below in my report.

EIS Section 3.10 is entitled Surface Water and provides a description of the site with reference to the Carrigower river. It explains that the majority of the surface catchment of the Carrigower river is up gradient of the site. The surface catchment area is defined as 49 square kilometres. The total surface catchment area above a gauging station, presumably at the confluence with the Slaney, is 53 square kilometres. The surface catchment may not be the same as the groundwater drainage catchment contributing to the Carrigower river because the western side of the catchment is underlain by sands and gravel deposits. The floor of the valley is a candidate SAC. The applicant has estimated the flows in the Carrigower river adjacent to the site. The third column of table 3.10.2 should be m3/day and not m3/sec. There is no description or discussion of the nature of the Carrigower river catchment area. The eastern side of the catchment drains water from the west of the

Wicklow Mountains. Therefore this part of the catchment is likely to contribute high flows generated by rapid run off from relatively steep slopes. The western side of the catchment is underlain by sands and gravels. Runoff is likely to be less in this area, and groundwater recharge, and later discharge, are likely to be more important. In other words the river may experience floods during heavy rainfall in winter, but will also receive a steady flow of groundwater released from the gravels in summer. These aspects of the catchment area and nature of the river flow have not been discussed. The potential problem of flooding and erosion along the eastern edge of the proposed landfill is not discussed in the EIS. There are proposed soak holes and stormwater wetland soakaways on the eastern boundary of the proposed landfill site. There is no discussion of river flood events in relation to possible inundation of the excavation of the unauthorised waste in Zone B adjacent to the flood plain.

Section 3.10.1.2 describes five small drains in the lowlands adjacent and down gradient of the quarry. Some of these drains contain water, others in December 2003 and January 2004 appeared to be dry.

The applicant's consultants took grab samples of water from the Carrigower river upstream and down stream of the site and the results showed no evidence of leachate. No samples appear to have been taken at the end of a long dry period in summer when water levels in the river are lower and dilution of contaminants is less.

In Section 3.10.2, entitled Potential Emissions, the applicant refers to emissions from the site being carried as surface water in the five drainage channels to the Carrigower river. Again there is no reference to groundwater contributing to the Carrigower river and the Carrigower river being affected by contaminated groundwater from the site.

In section 3.10.3, entitled Description of Likely Impacts, the applicant nearly refers to the groundwater flow system transporting leachate from the site to the river. The first statement in this section reads as follows :-

"A potential impact from the present situation includes leachate from previously deposited wastes seeping into low lying areas of the site and subsequently into the River Carrigower".
The mechanism or route by which these leachates move from low lying areas of the site to the river is not described.

It is of interest to note the applicant's observation that little or no liquid was observed during the trial pit investigation of the existing waste deposits. The applicant provides no interpretation of this observation. Assuming that the wastes generated leachate, an obvious interpretation is that a) the wastes are permeable and the leachate has percolated away, and b) the groundwater system below or adjacent to the waste is equally permeable and has not impeded the flow of leachate out from the waste. In other words the existing waste is not underlain or surrounded by low permeability clays or other sediments that have impounded the leachate and prevented it seeping out into the groundwater system.

The penultimate sections of the EIS on surface water essentially repeat the confusing description of likely impacts and mitigation measures that was provided in the section on groundwater.

The final section of the EIS on surface water predicts that the engineered landfill will have no impact significant or otherwise on surface water. This is followed by an odd statement that appears to predict that a new landfill, without the engineered lining and leachate containment, is unlikely to have a significant or measurable impact on surface water chemistry or the aquatic habitat. This statement almost seems to imply that an unlined landfill containing new and old waste is a development option.

2.2 Preliminary Risk Assessment Reports

The main description of the site is contained in EIS Appendix 9 Preliminary Risk Assessment (March 2004). A second version of the Preliminary Risk Assessment was submitted to the EPA in May 2005 and submitted to the Board on the 18 th July 2005.

It might be reasonable to assume that the later version would contain all the information presented in the earlier version, but this is not so. There are considerable differences in content and structure between the two Preliminary Risk Assessment Reports. For example the March 2004 report contains a 6 page description of the Trial Pit Assessment complete with photographs of some of the waste found in the pits. The May 2005 report only contains a 1.5 page summary of the results from the Trial Pits.

Below is a summary of the chapter titles for the two reports in order to illustrate the differences.

March 2004 Report	May 2005 Report
Contents	Contents
1. Introduction	1. Introduction
2. Review of Existing Environment	2. Review of Existing Environment
3. Trial Pit Assessment	3. Trial Pit Assessment
4. Waste Types and Quantities	4. Baseline Groundwater Assessment
5. Soil/Fines Assessment within Waste Zones	5. Baseline Surface Water Assessment
6. Leachate Assessment within Waste Zones	6. Landfill Design – Proposed Facility
7. Groundwater Assessment	7. Surface Water/Groundwater Impact Assessment
8. Surface Water Assessment	8. Risk Assessment
9. Landfill Gas Assessment	9. Conclusions
10. Surface Water/Groundwater Impact Assessment	10. References
11. Risk Assessment	
12. Summary Comments on Potential Impacts and risks	

The list of figures in each report are comparable with one extra figure showing proposed monitoring points included in the May 2005 report. The list of tables in each report contain some similarities but also differences. The May 2005 report contains a separate report as appendix 2 prepared by Golder Associates in the UK entitled report on "Landsim V2.5 Performance Assessment of the Proposed Non Hazardous Waste Landfill at Whitestown Lower Co. Wicklow". The Golders report also contains five appendices mostly containing simulation results.

It appears that the first Preliminary Risk Assessment Report contains a full description of the basic trial pit and borehole drilling results and a risk assessment of the present quarry containing the existing wastes. It does not consider the risks posed by the proposed landfill. The second Preliminary Risk Assessment Report provides a full description of the landfill design and a more extensive risk assessment as requested by the EPA.

I therefore intend to describe and discus the relevant information in the first part of the Preliminary Risk Assessment March 2004, where it adds significantly to the information in the EIS and the conceptual understanding of the groundwater flow under the site. I then intend to describe and discus additional relevant information on the conceptual understanding of the groundwater/surface water systems, the landfill designs and the impact assessment in the second Preliminary Risk Assessment Report May 2005.

First Preliminary Risk Assessment Report March 2004

The first two chapters of this report reiterate the groundwater and surface water text in the EIS.

The third chapter provides new information on the results of the trial pit investigation. 67 trial pits were excavated on the site. Figure 1 shows a composite of the aerial photo of the site with the addition of the three zones containing unauthorised waste and a series of dark brown dots showing the location of the trial pits. It can be seen that the trial pits are concentrated in the east of the site but do not extend out onto the flood plain of the Carrigower river.

An excavator with a 7 metre reach was used to construct trial pits. Many of the pits were less than 7 metres deep presumably because the sides collapsed. The pits were mostly dug in the areas where waste had been dumped.

The waste in Zone A (northern zone) appears to be over 5 metres thick, recent waste from commercial and industrial sources. No leachate was found in the pits.

The waste in Zone B (southern zone) is not described in detail but mostly consists of fine material and soils. No leachate was found in the trial pits.

The waste in Zone C (central zone) appears to date back to 1998. The waste smells strongly of decomposition and leachate was identified in the waste.

Chapter 4 tabulates the type of existing waste. Most of the waste is classified as inert (194,000 tonnes) the remainder is classified as 'non-readily biodegradable wastes' (33,000 tonnes) and 'readily biodegradable wastes (13,000 tonnes). These estimates indicate that thought there is nearly a quarter of a million tonnes of waste most of it is unlikely to generate leachate. Therefore the leachate generated by the present waste is unlikely to be representative of the quantity and chemical nature of the leachate that will be generated by the proposed landfill, which will include, for example, domestic waste. A comment in Chapter 6 states that the wastes in Zones A and C were probably deposited between 1995 and 2001 and may not yet have reached their full leachate producing potential.

Chapter 5 describes an investigation of the soils below the wastes in order to determine whether they have been adversely affected by the waste. With the

Figure 1 Trial Pit Locati

exception of a few samples showing slightly elevated levels of sulphate or diesel range organic compounds, the soils are largely unaffected.

Chapter 6 describes the results of leachate sampling in the waste. Only two samples were obtained. The applicant states that this is partly due to the clay silt cap on the wastes restricting the amount of rainfall entering the waste. However it may be equally due to the permeable nature of the waste and the permeability of the underlying sands and gravels. The results of the analysis of the samples indicate the presence of contaminants within the waste.

Chapter 7 is entitled Groundwater Assessment. It starts with a useful table giving a summary of the characteristics of the boreholes drilled on and around the site before the applicant acquired the site. In the final column it provides an indication of the presumed location of the open hole or screened section of these boreholes. For example it indicates that some boreholes are presumed to be open and measuring the water level or quality in the bedrock, and others open in the overburden. It is frustrating that the Board has not been provided with more accurate information on the construction of these holes in order to make a more informed interpretation of the data obtained from each hole.

Chapter 7 curiously starts by describing the sampling of the existing boreholes and the boreholes drilled by the applicant in February 2004. It does not start by describing the water level or permeability information, and then lead on to a discussion of the groundwater flow system, prior to discussing the results of the sampling. I will reverse the order.

Section 7.4 describes the drilling carried out for the applicant. Five boreholes were drilled. Figure 2 shows a composite map combining a detail from the aerial photograph of the site, with the location of boreholes and the location of the trial pits. The figure also includes 'indicative groundwater level contours' for February 2004 at 2.5 metre contour intervals. These details are copied from figure 3.7.4 in the May 2005 Risk Assessment Report. I have chosen to combine the details from this recent map because it shows groundwater flow direction arrows that indicate flow from the site to the river. The boreholes drilled for the applicant are shown in red, whereas the existing or previous boreholes (for which there is limited construction data) are shown in pink.

The five boreholes drilled for the applicant are divided into two groups.

Boreholes MW04-1 to –3 are drilled in the floor of the quarry where the bedrock is close to the surface. These holes encountered groundwater in the fractured and weathered Butter Mountain slates.

Boreholes MW 04-4 and –5 are drilled on the eastern side of the waste and the quarry and encountered 8 metres of principally natural clayey sands and gravels, coarse sands, and coarse gravels. These boreholes also penetrated three metres into the slate bedrock, which is weathered. The open response screened zone in the latter two boreholes does not discriminate between the bedrock or the overburden aquifers. The first group of boreholes have response zones in the bedrock aquifer only.

The applicant appears to consider the overburden and bedrock aquifers to be in hydraulic continuity, and hence has drawn an 'indicative' water table map that roughly reflects the water levels in the bedrock and the overburden combined. This appears to be reasonable and justified, and points to a combined groundwater flow system below and through the existing quarry.

The applicant refers in section 7.6 to an upper saturated zone. In February 2004 the applicant determined the permeability of the combined overburden and weathered, fractured Butter Mountain slates by analysing the particle size distribution from overburden samples, and by carrying out rising head tests on 22 boreholes. The estimated permeability is given as ranging from $4.41x10^{-4}$ to $3.24x\ 10^{-5}$ m/sec. These numbers appear at first glance to be small, but the units used are metres per second. The values converted into metres per day (a common hydrogeological set of units) range from 38 m/day to 2.8 m/day. These values are similar to the values for unconsolidated sand, or moderately productive karst limestone aquifers. In other words the combined weathered fractured bedrock and overburden sand and gravel, aquifer is a permeable aquifer which, if extensive and thick, would normally be regarded as a regionally important aquifer.

The applicant's information on groundwater flow shows that below, around and down gradient of the site there is a permeable aquifer, and the groundwater flow direction is from the site towards the Carrigower river. The applicant has not determined the permeability, thickness or other aquifer characteristics of the alluvium on the flood plain of the river, or determined the thickness of the sands and gravels or weathered fractured bedrock aquifer below the river.

Groundwater sampling was carried out in December 2003 and February 2004. The first sampling had full range of parameters analysed. The second sampling was for a more limited range of parameters on principally the new boreholes. The results are given in tables but the values for metals, hydrocarbons, trace organics are below detection limits. The results show that there is little difference between the groundwater up gradient or down gradient of the waste on the site. There is one chromium value that is just above detection limits, some of the ammonia values are high and one sulphate value down gradient is also high. However there is no evidence of a large, distinct plume of potentially harmful leachate leaving the site.

Chapter 8 entitled Surface Water Assessment is a short chapter that principally high lights

- The decline in quality of the Carrigower river over the last 10 years to a slightly polluted status both up stream and down stream of the site.
- The extension of the River Slaney candidate SAC to include the Carrigower because of the river's importance for salmonid spawning and otters

Chapter 9 describes landfill gas surveys that proved negative in December 2003 but showed evidence of methane in waste Zone A in February 2004.

Chapter 10 entitled Surface Water/Groundwater Impact Assessment is a chapter that contains important observations, calculations and concepts that should have been included, or at least summarised, in the main EIS. The chapter contains a conceptual model built up in stages.

The first stage is a description of the hydrostratigraphic units. The applicant states that the principle unit is the saturated sand, gravel and upper zone of fractured bedrock. The applicant 'infers' that this unit is 2-4 metres thick. There is no data provided to support this inference. The applicant's boreholes encountered 6 or more metres of saturated sands, gravels and weathered fractured bedrock. It would be reasonable to assume that the rock is fractured throughout and in some zones will be shattered by faults.

The applicant states that the active zone of groundwater movement is hydraulically linked to the Carrigower river.

The applicant states that "It is noted that the thickness of the overburden may be quite limited east of the site (i.e. less than 1 .0 metres in places), in the river flood plain." This is a very carefully worded statement that suggests that the bedrock under the flood plain is specifically less than 1 metre thick. However there appears to be no data to support this statement.

The applicant has presented cross sections through the site in figure 3.7.5. I have scanned and compressed the horizontal scale of these sections in order to reproduce them for ease of reference as an A4 figure (Figure 3). It can be seen that they have been compiled using trial pit and borehole information. However there are very few detailed reference boreholes that fully penetrate the overburden and or waste and define the position of the bedrock. It can be seen that the sands and gravels shown in yellow form a thick layer below the alluvium in the southern section C. The other sections imply that the bedrock is close to the surface and the sands and gravels terminate abruptly at the edge of the flood plain. There does not appear to be any data to support this.

The southern section C has a comment by the applicant that there is ' Ponding on Surface" at the north western end of the section on the quarry floor. During my site visit on the 22nd July 2005 I found that bedrock is exposed in the floor of the quarry at this point and groundwater is flowing from the rock, across the surface and then ponding below a gravel cliff. The water is seeping away into the gravel aquifer.

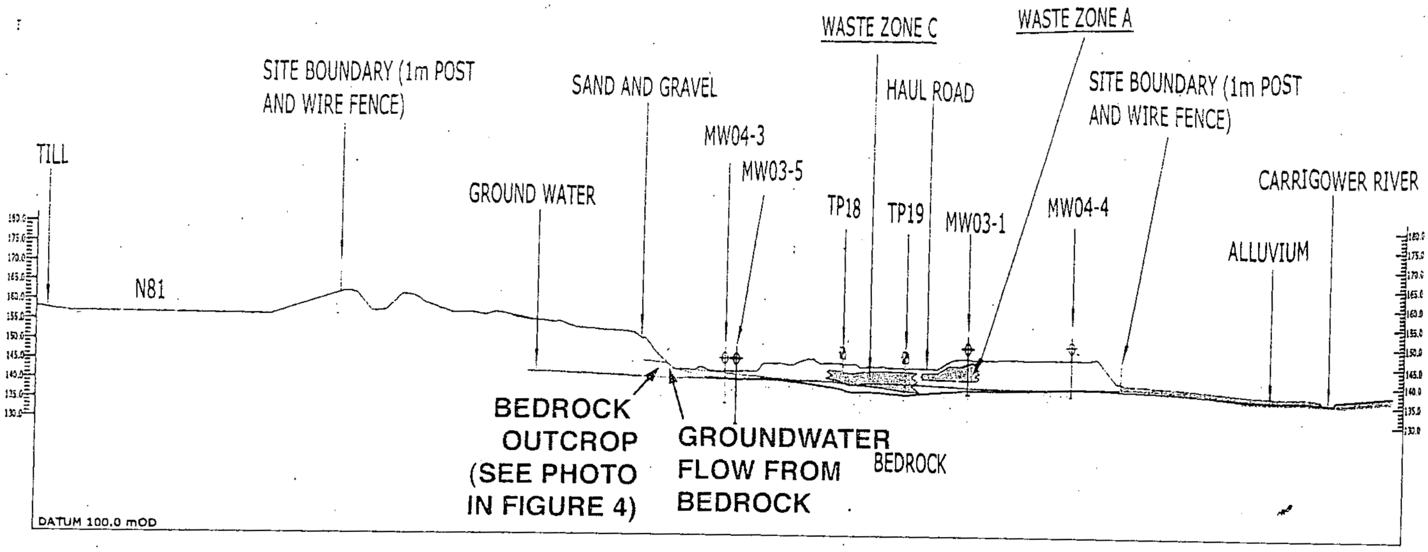
During the same visit I observed a substantial outcrop of shattered and weathered Slates at the northern end of the quarry, roughly on Section A. This outcrop appears to have been partly excavated to reveal a large spring seepage face. These two springs from the bedrock are noted in my comments in red on the cross sections. The northern spring and the outcrop of slate are shown in the photographs taken on the 22 nd July in Figures 4 and 5.

Neither spring, nor the northern outcrop, are shown on the cross sections presented by the applicant.

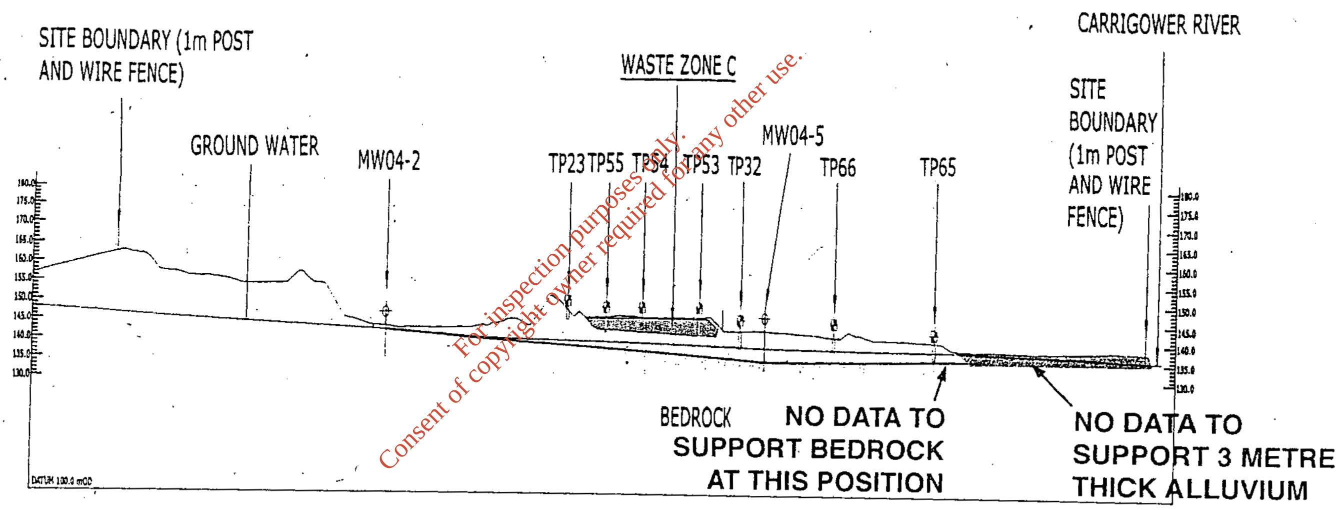
The applicant has estimated the groundwater catchment area for the quarry and estimated that there is a groundwater flux or flow of 700 m^3/day through the site.

The applicant has compiled a list of hydrogeological parameters in order to calculate the speed with which this water moves through to the river. The estimated values appear to be reasonable for purposes of this exercise. The conclusion is that groundwater emanating from the existing waste will travel at a velocity of 0.1 to 1.0 metres per day towards the river. Depending upon the distance to the river

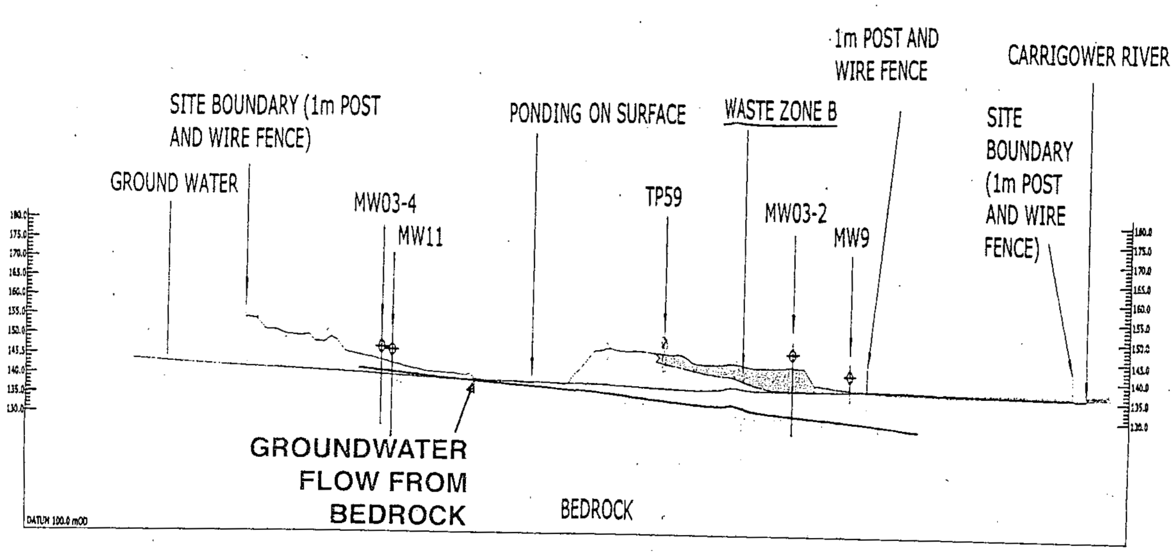
Figure 3 Cross Sections with commen



SECTION A

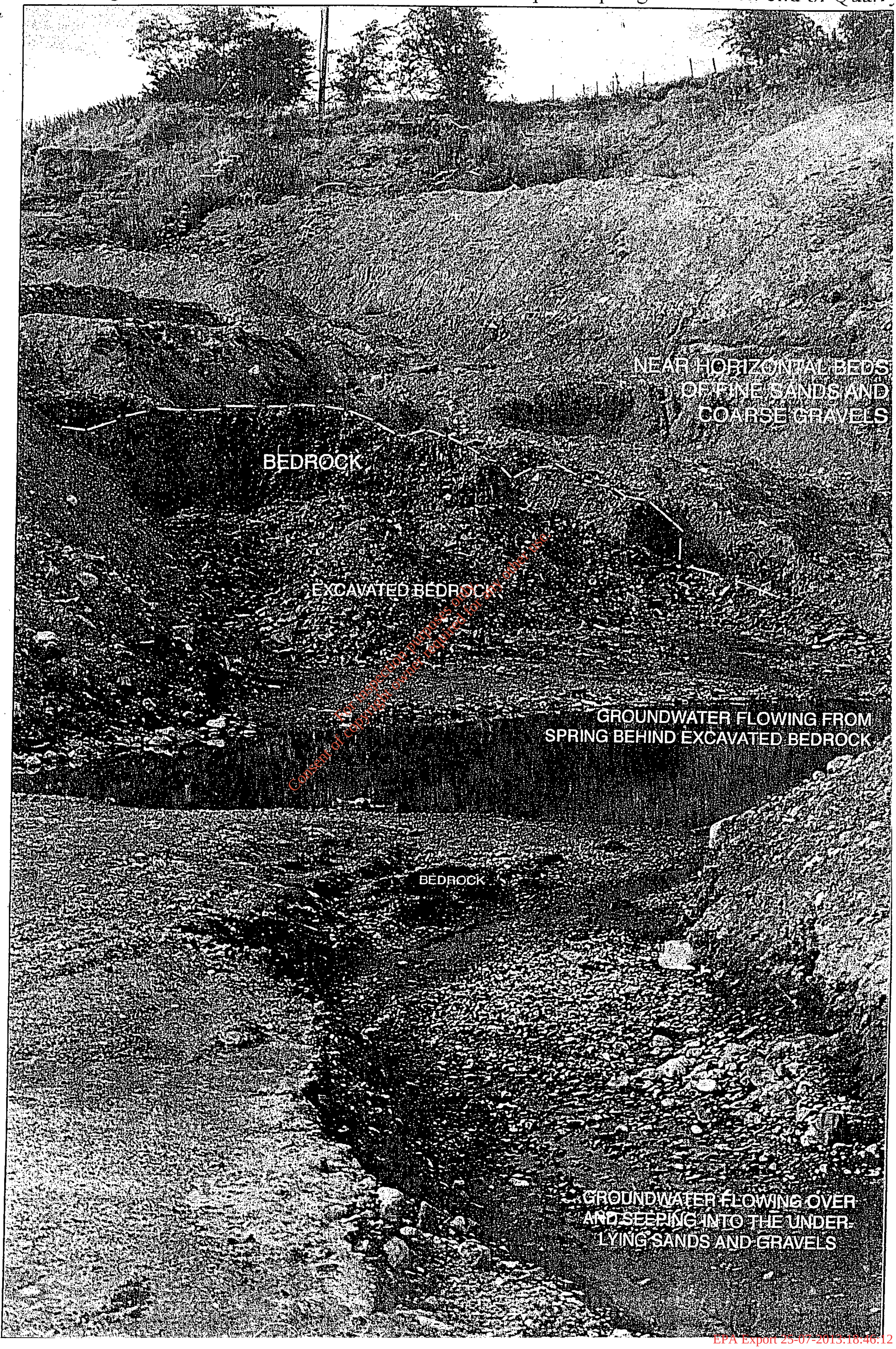


SECTION B



SECTION C

Figure 4 Butter Mountain Slate bedrock outcrop and spring at northern end of Quarry



groundwater from below the waste could reach the river in of 2-3 months. The applicant stresses that the time scale may be longer depending upon the permeability of the alluvium. However the applicant does not extend the implications of this statement and explain, that if the flow rates through the sands, gravels and fractured rock are correct, and the alluvium then holds up this flow of water before it enters the river, then the water in the sands, gravels and bedrock will back up, water levels will rise, and groundwater will flow into the small drains on the flood plain. There was little evidence of flow in these drains observed by the applicant in 2003-4. It is therefore reasonable to assume that the alluvium does not impede the groundwater flow, and there is a good hydraulic connection between the groundwater flow system and the river channel.

In the latter part of Chapter 10 the applicant uses the above calculations in order to estimate the amount of leachate reaching the river from the present waste and the impact that this should have on the water quality in the river. I will not describe this in detail because it is more important to consider the applicant's conceptual model in relation to the proposed development of a landfill. However the applicant does reach a conclusion that the present waste on the site in a 'worst case scenario' should produce leachate that would reach the river and increase the present river ammonia levels by 213%. This significant impact does not appear to have occurred, but in the past there was little monitoring of water quality in the river.

The final two chapters provide a risk assessment relating to the present wastes deposited on the site. The final chapter provides a summary and a range of alternative solutions to the risk posed by the existing waste. The applicant has prepared a second Preliminary Risk assessment Report for the EPA on the basis of one of these options which is to excavate the wastes, treat them on site and place them in a lined landfill.

Second Preliminary Risk Assessment Report May 2005

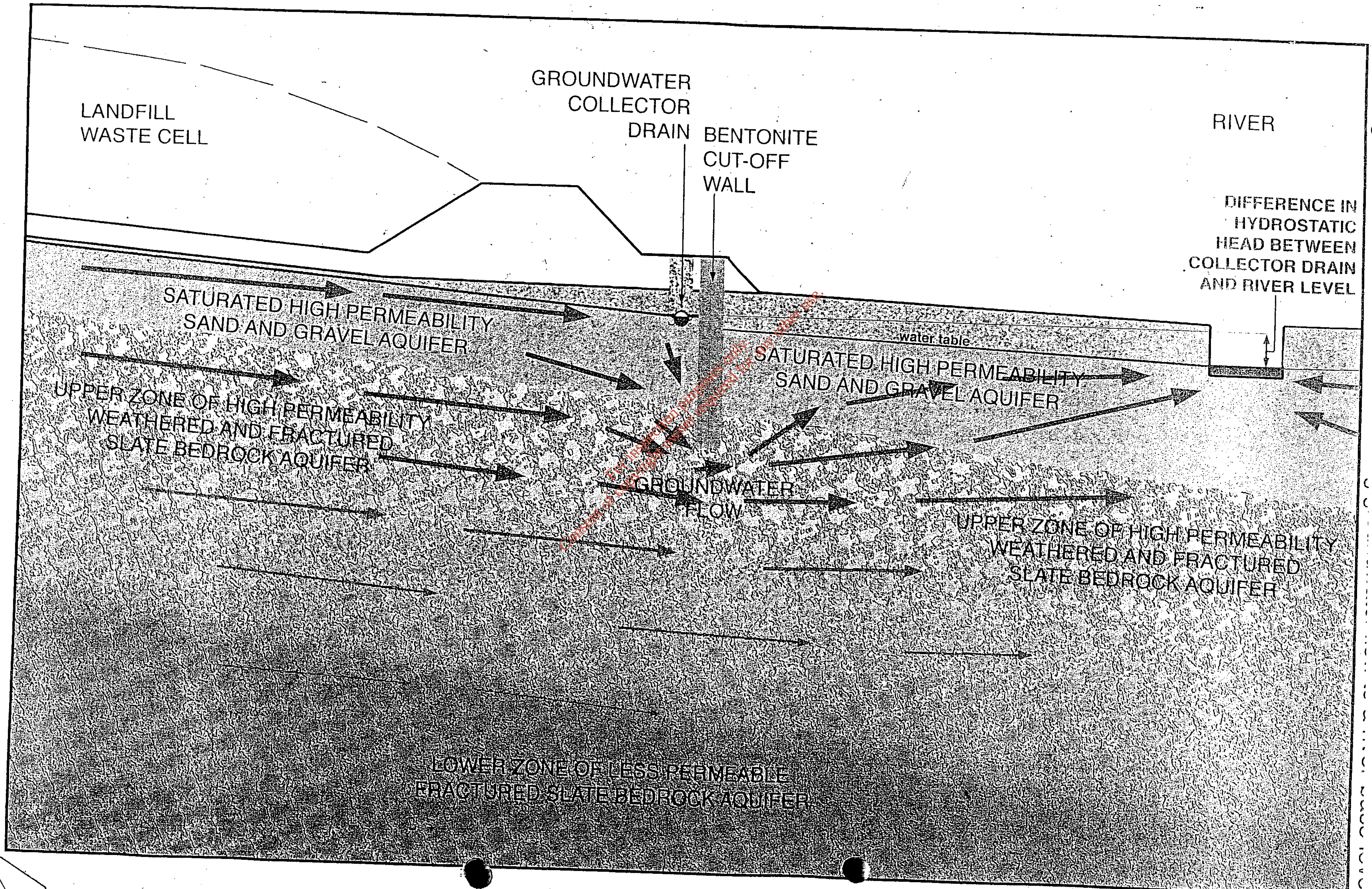
The first 5 chapters of this report summarise parts of the first report.

Chapter 6 provides a description of the proposed landfill design. The first 3 subsections of Chapter 6 describe the existing waste and the proposed future waste stream. This includes wastes from nearby unauthorised sites in West Wicklow, new commercial, industrial and demolition wastes, dry recylable and, or, organic wastes and household waste from nearby towns.

Section 6.4 describes the design of the Residual Waste Disposal Facility (Landfill). The applicant proposes to recover and compost waste before depositing it in lined cells. The cells will be constructed in stages. The existing quarry (after the remaining commercial sand and gravel has been removed) will require 'cut and fill' in order to shape the pit into a useable void. Figures BRI /110, /112 are plans that show the base of the proposed pit in relation to the bedrock topography and the groundwater water table. Figures BRI / 113 – 119 are a series of cross sections and section details that show the relationship between the engineered landfill design and the bedrock / water table.

All of these drawings and sections are based on limited data and appear to contain inconsistencies and flaws which may have a significant bearing on the effectiveness of the constructed features in the landfill.

Figure 5 Part of the Spring seepage from the weathered and fractured Slate bedrock



LANDFILL
WASTE CELL
GROUNDWATER
COLLECTOR
DRAIN
BENTONITE
CUT-OFF
WALL
RIVER
DIFFERENCE IN
HYDROSTATIC
HEAD BETWEEN
COLLECTOR DRAIN
AND RIVER LEVEL
SATURATED HIGH PERMEABILITY
SAND AND GRAVEL AQUIFER
water table
SATURATED HIGH PERMEABILITY
SAND AND GRAVEL AQUIFER
UPPER ZONE OF HIGH PERMEABILITY
WEATHERED AND FRACTURED
SLATE BEDROCK AQUIFER
GROUNDWATER
FLOW
UPPER ZONE OF HIGH PERMEABILITY
WEATHERED AND FRACTURED
SLATE BEDROCK AQUIFER
LOWER ZONE OF LESS PERMEABLE
FRACTURED SLATE BEDROCK AQUIFER

Figure 2 Borehole Locations and "indicative groundwater level contours" 3rd February 2004

It is important to note that the water table elevations shown on the design drawings are based on one set of water level measurements made in February 2004. The water table contours used in the design drawings are not based on measurements that reflect the natural seasonal fluctuation of the water table. These contours do not appear to reflect the spring flow of groundwater observed in the south and north of the existing quarry during my site visit in July 2005. If springs from the bedrock are evident in summer it is likely that they will also occur in winter with a greater flow, and perhaps at a higher level. The spring level in the south appears to be at about 142-143 mOD whereas the groundwater level in detailed design section D (Figure BRI / 114–2) shows the water table at 141mOD.

Figure BRI /112 shows that the applicant proposes in Phase 6 and perhaps in Phase 1 to cut back into the bedrock at the north and south of the quarry. This cut, particularly in the north will also intersect and go below the water table in the bedrock as observed in July 2005. This is not shown on the figure.

The applicant also proposes to construct a bentonite-cement cut off wall, as described in report sub section 6.4.5, up gradient and down gradient of the landfill. The applicant states that the bentonite cut off wall will be keyed to a depth of at least one metre into the bedrock or 1 metre below the water table in the bedrock. The objective of the lower cut off wall will be to provide a barrier to any leakage of leachate through the landfill base.

The applicant also proposes in both cases to construct a collector drain up gradient of the bentonite cut of walls. The text describes this collector drain as comprising a stone backfilled excavation below the water table. The various cross sections by contrast show it as a pipe at the base of an excavation, presumably back filled in part with rock or pebbles.

There are three fundamental problems with the design of a cut off wall and a groundwater collector drain.

The first is that the applicant does not have information on the seasonal fluctuations of the water table and therefore does not, at present, know the optimum position for either the drain or the cut off wall.

The second is that the upper highly fractured and weathered permeable zone in the slate bedrock will in some places probably extend to a considerable depth. The Butter Mountain Slates are ancient. They have been deformed over millions of years and they have been exposed to weathering for millions of years. It is not possible to predict accurately the zones of high permeability, which may be vertical, or horizontal, or any angle in between. It is a common experience during groundwater investigation drilling in Ireland, to find that the high permeability weathered zone in brittle fractured rocks extends to 20 to 30 metres below the rock head. In heavily glaciated areas the weathered zone may be thinner, but at this site the depth is not known because all the investigation boreholes have been shallow.

The third fundamental problem is that the site is sloping, the base of the landfill is sloping and the existing water table is sloping towards the river. There is a relatively steep groundwater gradient towards the river. The river is the local base level, to which, all water flows. As long as there is a head difference between the base of the groundwater collector drain and the water level in the river, there will be the potential for groundwater to flow under the bentonite cut-off wall. If the rock or sand and gravel below the cut off wall is permeable this groundwater flow will take place.

The applicant has stated that the upper bedrock is very permeable, with a fracture permeability similar to the sand and gravel permeability. The two aquifers have been grouped into one hydrostratigraphic unit by the applicant. A cut-off wall 1 metre into the bedrock, or 1 metre below the water table level in the bedrock, will not provide a barrier to groundwater flow. Even if it extends 5 metres below the rock head there may still be high permeability zones in the bedrock below the base of the wall.

The fundamental problems with the proposed collector drain and cut-off wall are illustrated in the schematic drawing in Figure 6 which is roughly based on the down gradient part of Section C in the applicants drawings BRI / 113 and 114-1. It can be seen that there is no sharp well defined line or point where the bedrock aquifer changes from high to low permeability. It can be seen that the groundwater at the base of the groundwater collector drain is higher than the water level in the river.

The design concept of a bentonite cut off wall might work if the area was flat, the groundwater gradient was nearly flat and the river was a considerable distance away. It might also work if the rock or other sediments below the cut-off wall were, for example, low permeability clays or totally un-fractured solid bedrock. However these are not the conditions at the site.

The applicant might suggest that, at the final design stage, the invert of the groundwater collector drain would be placed at the same elevation as the river bed. In other words eliminating the head difference illustrated in figure 6, and the potential for groundwater flow when river levels are low. Such a design would work whilst the sump pumps are working, and the landfill is under the care of the operators. However when the site is no longer under care and the pumps are turned off, the natural groundwater gradient and flow to the river will become rapidly re-established. Placing a groundwater collector drain at, or below, the river level will induce reverse flow under the bentonite wall as long as the pumps are running. This would increase running costs for the applicant.

Chapter 6 continues with descriptions of the composite liners, leachate generation, collection and treatment and the capping system. These design features are standard and will probably be adequate pre-closure of the site. The separation provided by unsaturated bentonite and imported low permeability soils between the base of each landfill cell and the groundwater level will depend upon the long-term condition of the drainage blanket and collector drains. The applicant does not appear to intend to separate the fine grained soils from the drainage blanket by means of a geotextile.

Chapter 7 restates the Conceptual Groundwater Surface Water model described in the first Preliminary Risk Assessment Report. The chapter then continues with a summary of the findings of a special report completed by Golder Associates using the latest version of the UK Environment Agency software called LandSim Version 2.5. This software is used to predict the impact of a landfill after the care and management period has ended. The software model was run for the proposed landfill without the proposed bentonite cut off wall and groundwater collector drains. In other words the model has been used to predict the impact of the design failure described at length

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above. The result should therefore be very interesting. However the UK Environment Agency Memo on the use of LandSim in Appendix 1, states that

"In general the longer the management control period (years) the lower the overall impact of the site on groundwater."

The applicant has presented results for the LandSim model that assume "infrastructural control is maintained indefinitely"(Section 7.2.3). This assumption would appear to be very unlikely. Therefore I do not feel certain how much credence should be placed in the results of this modelling exercise.

Golder's report that there are several new developments coming on stream to speed up the decomposition of waste and stabilise the residues. These innovations plus changes in the nature of the waste stream may reduce the level of management control required in modern landfills in the future. However these new technologies are not a part of present design of the proposed development.

Chapter 8 concludes a risk assessment with assurances that the proposed landfill facility 'will not to any significant extent endanger human health or harm the environment'.

3. ASSESSMENT AND CONCLUSIONS

The applicant's understanding of the groundwater flow system below the site has evolved during the course of the planning process and the EPA licensing process.

The applicant's proposals for an engineered landfill have also evolved. The initial statements in the EIS tended to minimise or avoid the obvious link between the groundwater system and the river. Later submissions openly acknowledge that the groundwater flow is to the river and the potential speed of movement is large.

The entire proposed development depends upon engineering solutions lasting not just for the immediate future whilst the landfill is active, but also for several hundred years when the landfill will probably be left un-attended.

Whilst it is possible to believe that engineering barriers can remain intact for long periods, it is equally possible to believe that they will inevitably fail. The problem facing the Board is that these barriers and liners have not been field tested for a sufficiently long time. At present we do not know whether these engineering solutions can last for decades and centuries.

Current practice is to site engineered landfills in locations where there are obvious, well proven, natural barriers that can support the engineering barriers, and mitigate the impact of their failure. This, given the present state of knowledge, would appear to be a wise precautionary practise.

I have described and assessed the information presented by the applicant on the site characteristics and in particular the information on the overburden geology, bedrock geology, groundwater and surface water. My overall finding is that the information is incomplete and inadequate. There are logs for just six boreholes restricted to the centre and east of the site. The configuration of the bedrock below the site is poorly known. The depth and characteristics of the upper fractured and weathered bedrock is also poorly known. There is no information on the depth or characteristics of the important groundwater pathway between the site and the river. The thickness of the alluvium and or the sands and gravels under the flood plain has not been determined. Even the thickness of the sands and gravels on the site is poorly known. The applicants appear to have either missed or discounted the springs from the bedrock observed during my site visit in the middle of summer. The determination of the permeability of the overburden and bedrock aquifers have been determined using rising head tests on boreholes constructed by others, for which the applicant does not appear to have full details. No pumping tests have been carried out to determine the response of the groundwater system in different aquifers. Water levels have been monitored inadequately. There is no information on the annual fluctuation in water levels below the site. Groundwater sampling and analysis has also been limited, and inadequate, particularly given that there is unauthorised waste on the site. Overall there are large gaps in the information that would normally be expected and provided.

However with this inadequate information the applicant has realised that there is an active groundwater system below the site, and that this groundwater system is not protected by naturally occurring low permeability materials. The groundwater system is extremely vulnerable to pollution. The applicant has therefore proposed importing a low permeability layer in order to provide artificially emplaced natural barriers below the landfill cell liners. However the effectiveness of this separation between the leachate above the base of the liner and the top of the groundwater flow system depends upon artificial control of groundwater levels. The applicant has proposed, in outline, various measures, but because there is little information on groundwater levels and an incomplete understanding of the bedrock-overburden groundwater flow system there is an insufficient basis for detailed designs. For example the position of the bentonite cut-off wall and groundwater collector drain is not known, and as has been described above, it appears uncertain whether this proposal will be in anyway effective.

The proposed development of a major landfill at this site has arisen because the site already contains unauthorised waste. This site was not chosen after a long site investigation process that considered many alternative sites. However it is still important to stand back and ask the fundamental question whether the applicant's site would be chosen as a site for a modern landfill, using the present guidelines for landfill site selection.

The answer to this question is unequivocally negative. This answer is negative for three principal reasons.

1. The site is underlain by a permeable and extremely vulnerable aquifer. Groundwater moves easily through the aquifer, and the aquifer and water table has no natural protection

2. A major tributary of an important salmonid river is directly down gradient of the landfill, and less than 100 metres away from the landfill boundary.

3. There is an obvious, direct and rapid link between groundwater flowing below the proposed waste filled cells and this river.

In other words the site has no natural advantages that would place it on a short list of suitable landfill sites in the area. Aquifer characteristics, groundwater vulnerability and the proximity of a candidate SAC would eliminate the site at a reconnaissance assessment stage.

The use of the GSI-EPA response matrix for landfill site selection is not appropriate because the important issue is not the protection of groundwater resources, but instead is the protection of a groundwater flow system feeding an important river and aquatic habitat.

The applicant has put forward a range of engineered measures in order to try to compensate for the lack of natural advantages at the site. The detail in these measures can perhaps appear beguiling. However they appear to be based on a weak foundation of understanding, regarding the natural characteristics of the site and the movement of water through it.

I do not recommend that the Board should seek additional information. The existing information, though inadequate, demonstrates that the site is not suitable for a landfill.

I therefore recommend to the Board that planning permission is not granted.